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ENTOMOLOGY.—*The North American empoascan leafhoppers of the alboneura group (Homoptera-Cicadellidae).*<sup>1</sup> NANCY H. WHEELER,<sup>2</sup> U. S. Bureau of Entomology and Plant Quarantine. (Communicated by J. S. WADE.)

In 1898, Gillette,<sup>3</sup> using external characters only, described the widely distributed American leafhopper *Empoasca alboneura*. At the same time he also described two other species of *Empoasca*, *mexicana* and *tumida*, having certain external characters similar to those of *alboneura*. In the revision of the genus *Empoasca*, DeLong<sup>4</sup> redescribed the external characters of *alboneura* and included a description and illustrations of the internal male genitalia of this species, pointing out that *tumida* was a synonym and placing *alboneura* next to *aspersa* in the subgenus *Hebata*. Later, DeLong and Davidson<sup>5</sup> described and illustrated *confusa*, which externally closely resembles *alboneura* but internally is quite distinct.

The most distinctive external characters of *alboneura* and closely related species are the more or less bluntly rounded crown and the pale nervures of the forewings, the latter, by contrast, giving to most of the species of this group a more or less striped appearance. The species are all rather robust and range from 2.5 to 3.3 mm in length. In size and shape they are somewhat similar to the species of the *aspersa* group,<sup>6</sup> but are of a duller green color and lack the mosaic pattern of the forewings that is characteristic of the *aspersa* group.

With a view to bringing together the various species of this rather homogeneous group, of which *alboneura* is considered typical, a care-

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<sup>3</sup> Proc. U. S. Nat. Mus. 20: 743-744. 1898.

<sup>4</sup> U. S. Dept. Agr. Tech. Bull. 231: 35. 1931.

<sup>5</sup> Ohio Journ. Sci. 36: 229. 1936.

<sup>6</sup> Proc. Ent. Soc. Washington 40: 133-147. 1938.

ful study has been made of the specimens standing under the name *alboneura* in the United States National Museum collection. As a result, the type series has been found to be mixed, containing both *alboneura* and *confusa*. From a further examination of available collections for specimens resembling *alboneura*, two apparently undescribed species have been segregated. The group is now known to contain five different species, three of which have been previously described and illustrated.<sup>7</sup> For convenience, however, illustrations and descriptions of all the species of the *alboneura* group now known to occur in North America are included in this paper, together with some synonymical changes. A key to the males of the group is also offered as an aid in separating the various species.

KEY TO THE SPECIES OF THE ALBONEURA GROUP

1.    Lateral processes converging distally . . . . . 4. *confusa* DeL. and D.
- Lateral processes diverging distally . . . . . 2
- 2 (1). Dorsal spine vestigial. Lateral process very broad basally, in lateral view tapering abruptly and strongly curved dorsad . . . . . 1. *sonorana*, n. sp.
- Dorsal spine prominent. Lateral process relatively slender basally, in lateral view more or less sinuate, with sides almost parallel to near tapered apex . . . . . 3
- 3 (2). Aedeagus with two pairs of spinelike processes projecting dorsocaudad. Apex of dorsal spine short, bluntly pointed . . . 5. *mexicana* Gill.
- Aedeagus without spinelike processes. Apex of dorsal spine attenuated or sharply pointed . . . . . 4
- 4 (3). Dorsal spine sickle-shaped, apex attenuated. Lateral process, in lateral view, with both proximal and distal portions definitely sinuate; distal portion convexly curved on dorsal margin . . . 3. *alboneura* Gill.
- Dorsal spine not sickle-shaped, broad basally, abruptly narrowed medially, and terminating in a slender, pointed, toelike projection. Lateral process, in lateral view, with proximal and distal portions only slightly curved; distal portion concavely curved on dorsal margin . . . . . 2. *stylata*, n. sp.

*Empoasca sonorana*, n. sp.

Fig. 1

Resembling *alboneura* in size and general structure, but lacking the strongly contrasting veins of forewing; lateral process very broad basally and dorsal spine vestigial. Length, 3.25 mm.

*External characters*.—General color pale sordid green; head, thorax, and scutellum sometimes with irregular, paler areas. Posterior margin of seventh sternite of female faintly incised medially and faintly sinuate each side of median incision.

*Male internal structures*.—Lateral process very broad basally, tapering

<sup>7</sup> Subsequent to the submission of this paper for publication it was found that *Empoasca knulli*, described by Davidson and DeLong (Ohio Journ. Sci. 39: 111. 1939) is a member of the *alboneura* group. The original description, in which the species was compared with *similis* and *bicuspidata* (members of the *aspersa* and *fabae* groups, respectively), appeared without accompanying illustrations. *Empoasca knulli* may be differentiated from the other members of the *alboneura* group, here treated, by the bifurcate dorsal spine.

rather abruptly but evenly, in lateral view to sharply pointed apex curved dorsad, in ventral view to bluntly pointed apex directed caudolaterad. Style long, relatively slender, gradually tapering to sharply pointed apex directed caudolaterad. Dorsal spine vestigial. Aedeagus slender, extending upward from base, then bent directly caudad and broadly curved dorsad. Sternal apodemes rudimentary.

Holotype male, allotype female, and 3 male and 20 female paratypes from Cajene, Sonora, Mexico, June 1, 1927, A. W. Morrill, collector.

Type, U.S.N.M. no. 54190.

*Empoasca stylata*, n. sp.

Fig. 2

Related to *alboneura*, but larger, with venation of wings less conspicuous, dorsal spine stouter, and lateral process not broadened distally in ventral view. Length, 3.3 mm.

*External characters*.—General ground color pale sordid green tinged with fuscous; venation of wings obscure except apically. Crown with ivory spots and an ivory median line. Pronotum marked with three irregular ivory areas anteriorly.

*Male internal structures*.—Lateral process long, slender, with sides almost parallel to near pointed apex, with distal portion in lateral view concavely curved on dorsal margin and directed dorsocaudad, in ventral view curved caudolaterad. Style long, relatively broad at base, with tip bent laterad. Dorsal spine strongly curved first caudad, then ventrad and cephalad, broad basally, narrowed medially, and terminating in a slender, pointed, toelike projection extending cephalomesad from ventrocephalic margin. Aedeagus stout, process for muscular attachment extending at nearly right angles to shaft. Sternal apodemes fuscous, large, sacklike, and rounded apically.

Holotype male and one male paratype from Cajon Pass, Calif., June 6, 1935, collected by P. W. Oman, and one male paratype from Los Angeles, County, Calif., collected by D. W. Coquillett. The last-mentioned specimen was standing under the name *alboneura* in the Museum collection.

Type, U. S. N. M. no. 54191.

*Empoasca alboneura* Gillette

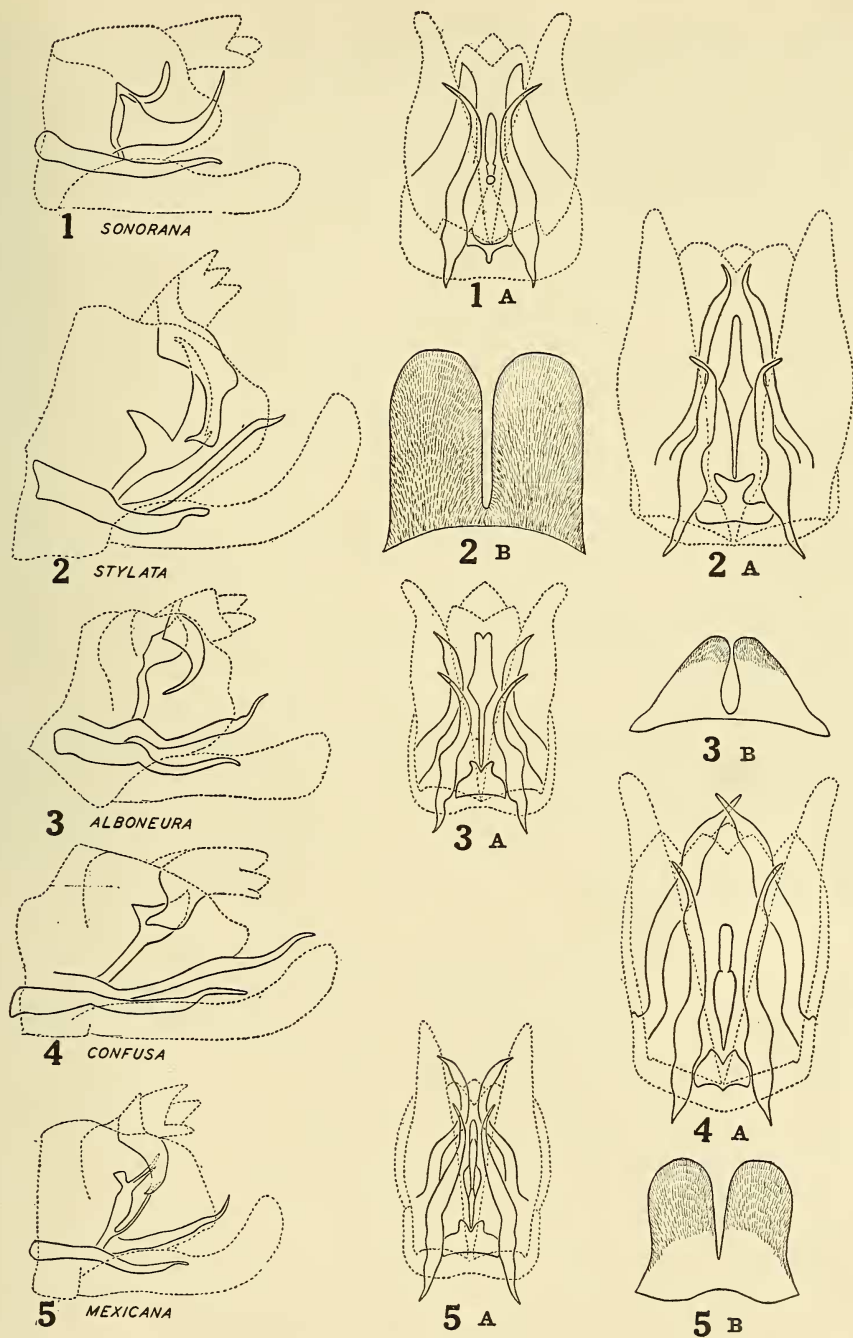
Fig. 3

*Empoasca alboneura* Gillette, Proc. U. S. Nat. Mus. 20: 743-744. 1898.

A relatively robust, dull-green species characterized by the pale nervures of the forewings, giving a conspicuously striped appearance. Lateral processes definitely sinuate and diverging distally; spine stout and sickle-shaped. Length, 2.5 to 3.5 mm.

*External characters*.—General color varying from yellowish green tinged with orange to dull green tinged with brown, veins pale and conspicuous. Crown relatively broad, bluntly rounded and slightly produced, with a light median stripe and an oblique dash on each side near the eye. Posterior margin of seventh sternite of female produced and rounded medially, with a very shallow and broad lateral emargination.

*Male internal structures*.—Lateral process in lateral view long, relatively slender and sinuate, with distal portion convexly curved on dorsal margin and tapered to pointed apex directed dorsocaudad; in ventral view, curving mesad to near middle, then laterad, with distal portion slightly broadened, then narrowed to pointed apex directed caudolaterad. Style long, with basal portion relatively broad, sinuate and abruptly narrowed near middle, with apical portion broadly curved and gradually tapered to bluntly pointed apex directed caudolaterad. Dorsal spine relatively stout and sickle-shaped,



Figs. 1-5.—Lateral and ventral (A) views of male genital capsule and ventral view (B) of sternal apodemes of (1) *Empoasca sonorana*, n. sp.; (2) *E. stylata*, n. sp.; (3) *E. alboneura* Gill.; (4) *E. confusa* DeL. and D.; and (5) *E. mexicana* Gill.  $\times$  ca. 60.



broadly curved and evenly tapered to attenuated apex directed ventrocephalad. Aedeagus broad distally. Sternal apodemes rather small, narrowed on lateral margins to bluntly rounded and slightly fuscous apices.

Originally described by Gillette from 15 females and 9 males from Mississippi Agricultural College, 2 specimens from Virginia, and 7 specimens from Colorado; specimens were also recorded from "D. C.," and from the U. S. National Museum marked "Va.," "Los Angeles, Calif., Coquillett," "Nevada Co., Cal., Sept.," "Horace, Ks., July 28," and "Neb.," the type being designated "No. 3437 U. S. N. M."

The type series now extant in the U. S. National Museum consists of two females with the Type no. 3437, one labeled Horace, Kans., and the other Lakin (?), Kans. Therefore, Gillette's cotype female in the U. S. National Museum (Type no. 3437) from Horace, Kans., is here designated lectotype.

More recently this species has been identified in miscellaneous collections from Alabama, California, Colorado, Connecticut, District of Columbia, Kansas, Kentucky, Maryland, Mexico, Missouri, Montana, Nevada, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Utah, Virginia, and Wyoming.

In the original description Gillette reported *alboneura* from "native plants" and from plum in Colorado. Later, DeLong<sup>4</sup> recorded this species as "distributed almost throughout the United States on herbaceous plants." Other records have been procured, from collections in various localities, of the occurrence of *alboneura* on alfalfa, *Anthemis cotula*, *Artemisia*, artichokes, aster, *Chrysothamnus*, giant ragweed, and white pine. This species has also been taken in trap lights at Arlington, Va., Knoxville, Tenn., and Richfield, Utah.

The accompanying illustrations and descriptions of this species have been made from a study and comparison of a number of males and females from series collected both in the East and in the West. There seems to be some variation in this species, both externally (in size and coloration) and internally (in the breadth and sinuation of the apical portion of the lateral process), but no greater differences have been noted between eastern and western specimens than between specimens of a series from the same locality and date of collection.

#### *Empoasca confusa* DeLong and Davidson

Fig. 4

*Empoasca confusa* DeLong and Davidson, Ohio Journ. Sci. 36: 229. 1936.

Superficially resembling *alboneura* but less conspicuously striped and less robust, with crown narrower and only slightly produced; lateral processes sinuate but converging distally. Length, 3 mm.

*External characters.*—General color fuscous-green, with venation of forewing pale. Posterior margin of seventh sternite of female produced and broadly rounded medially, with a small notch, on each side, laterally.

*Male internal structures.*—Lateral process long and sinuate; in ventral view broad, with distal portion narrowed to long slender point directed caudomesad; in lateral view more slender and tapered gradually to pointed apex directed caudad. Style relatively long, broad at base, with distal portion abruptly narrowed to long, slender apex directed caudolaterad in ventral view. Dorsal spine short, broad, concave on anterior margin, with a bluntly pointed, toelike projection extending cephalad from ventrocephalic margin. Aedeagus simple and relatively slender. Sternal apodemes rudimentary.

Originally described from a single male collected at Burns, Oreg., holo-

type male in the DeLong collection. The male and female herein treated, the former redescribed and reillustrated, are from a series of 18 males and 48 females collected at Mount Shasta, Calif., by R. H. Beamer. Other males and females at hand are from the following localities: CALIFORNIA: Bray (Oman). COLORADO: Durango, Livermore (Oman); Mesa Verde (Beamer); Poudre River Canyon (Sanderson). NEVADA: Reno (Beamer). OREGON: Bend (Oman). WASHINGTON: Cliffdell (Beamer); Mount Rainier (Oman). Four females of this species from Nevada County, Calif., were found under *alboneura* type no. 3437 in the U. S. National Museum collection.

### *Empoasca mexicana* Gillette

Fig. 5

*Empoasca mexicana* Gillette, Proc. U. S. Nat. Mus. 20: 737-738. 1898.

*Empoasca tumida* Gillette, Proc. U. S. Nat. Mus. 20: 744. 1898.

*Empoasca bitubera* DeLong, Ohio Journ. Sci. 32: 395. 1932.

One of the smallest species of the *alboneura* group, with crown rounded, but slightly more produced than in *alboneura*. Aedeagus with two pairs of spinelike processes. Length, 2.5 to 2.75 mm.

*External characters*.—Color yellowish to fuscous-green, with veins of forewing pale but not so distinct as in *alboneura*, except apically. Posterior margin of seventh sternite of female slightly produced and rounded medially, with slight lateral emargination.

*Male internal structures*.—Lateral process relatively long, broad, and tapered apically; in lateral view extending dorsocaudad, with distal portion narrowed on dorsal margin and curved upward; in ventral view sinuate, curved mesad about middle, with distal portion broadened slightly, then tapered to sharply pointed apex curved laterad. Dorsal spine broad at base, broadly curved caudoventrad, with bluntly pointed apex directed cephalomesad. Aedeagus unusual, having a pair of long, narrow, spinelike processes projecting dorsocaudad from near base and another, shorter pair arising similarly but more dorsally. Sternal apodemes medium sized, slightly fuscous, and rounded apically.

This species was originally described by Gillette from five females collected near Veracruz, Mexico, and was given U. S. N. M. type no. 3430. Later, DeLong redescribed *mexicana*, in the absence of Gillette's type material, from specimens in the collection of the U. S. National Museum, labeled Marfa, Tex., June 5, 1908, Mitchell and Cushman, collectors. As previously indicated by the writer,<sup>8</sup> from an examination of this series now extant, the external markings and internal structures of the male were found to be identical with those described and figured later by DeLong for *bitubera*, and *bitubera*, therefore, was placed as a synonym of *mexicana*.

An examination of the type of *tumida*, a female in the U. S. National Museum, labeled "Colo. 1658" (type no. 3438), has shown this form to be specifically identical with females from Marfa, Tex., identified as *mexicana* by DeLong. Therefore, *Empoasca tumida* is also placed as a synonym of *E. mexicana*.

For the sake of uniformity, *mexicana* is herein redescribed and reillustrated from the series collected at Marfa, Tex., June 5, 1908, now consisting of 1 male (dissected), 3 females, and 2 specimens with abdomens missing. Other material has been examined from various localities in Arizona, California, Colorado, Nevada, New Mexico, Texas, and Utah.

<sup>8</sup> Journ. Washington Acad. Sci. 29: 300. 1939.